Results and Lessons Learned from USArray

Frank Vernon

Scripps Institution of Oceanography
University of California, San Diego

AUG Rome, Italy

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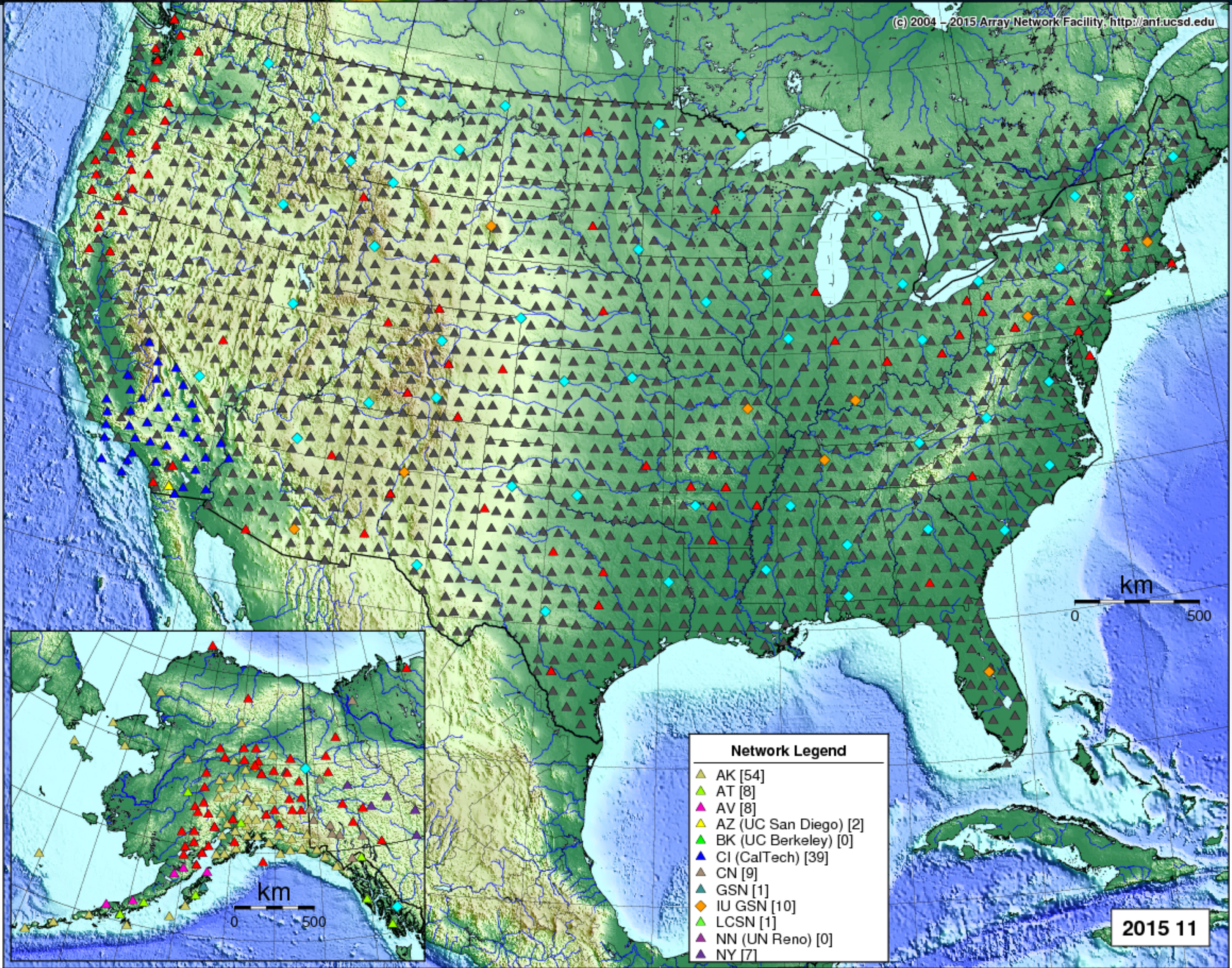
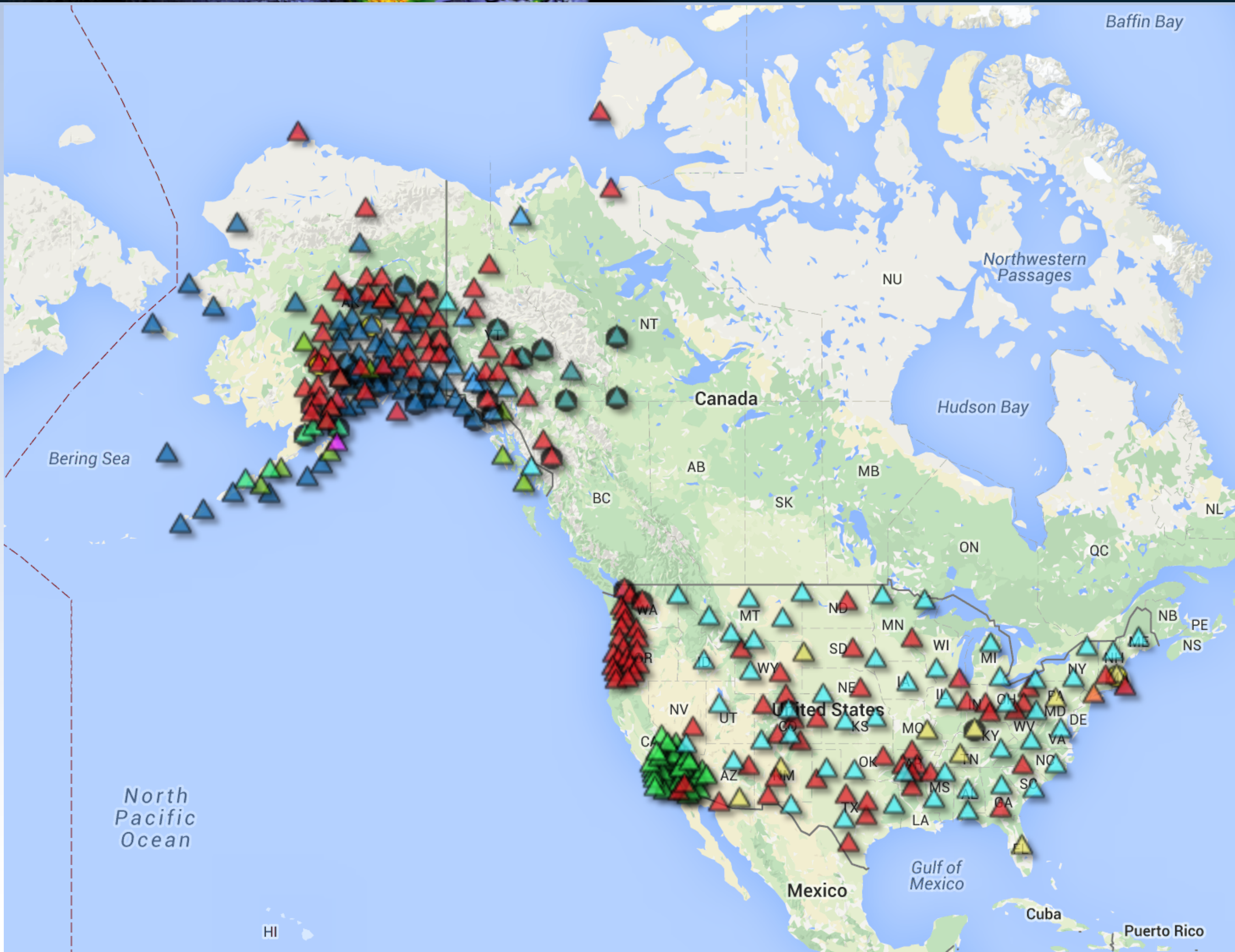
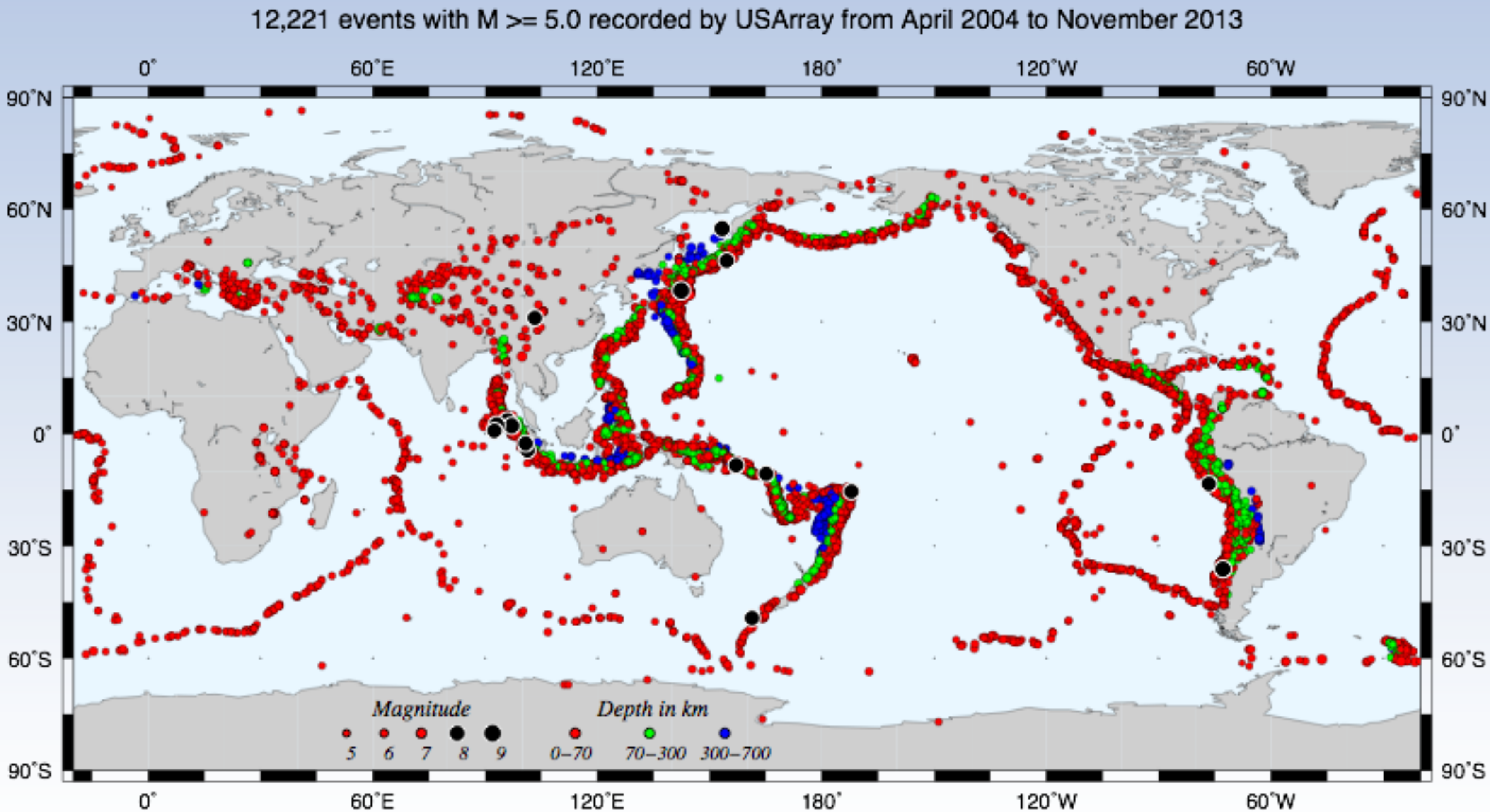
USArray TA 2004-2015



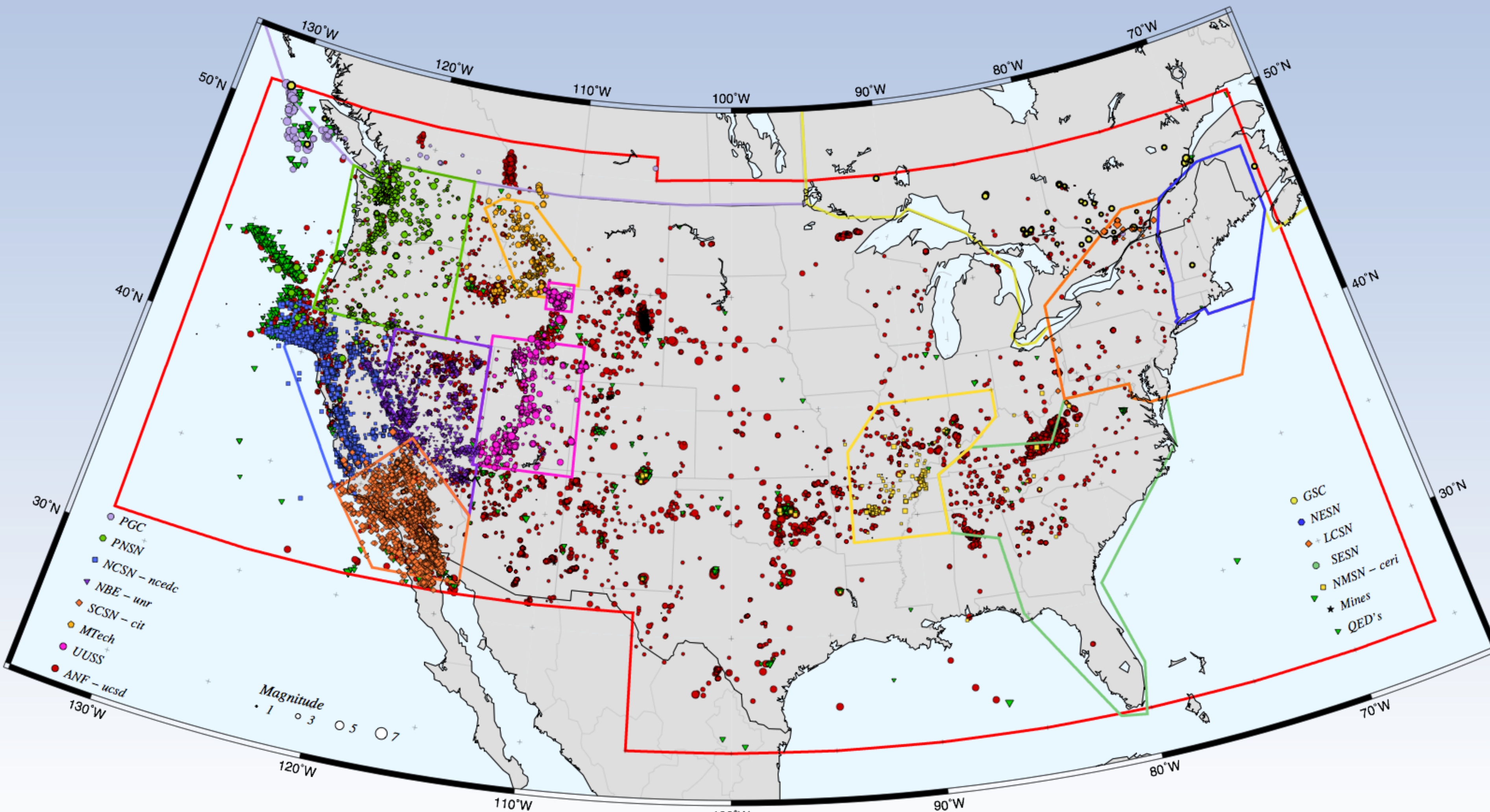
USArray TA May 18, 2016



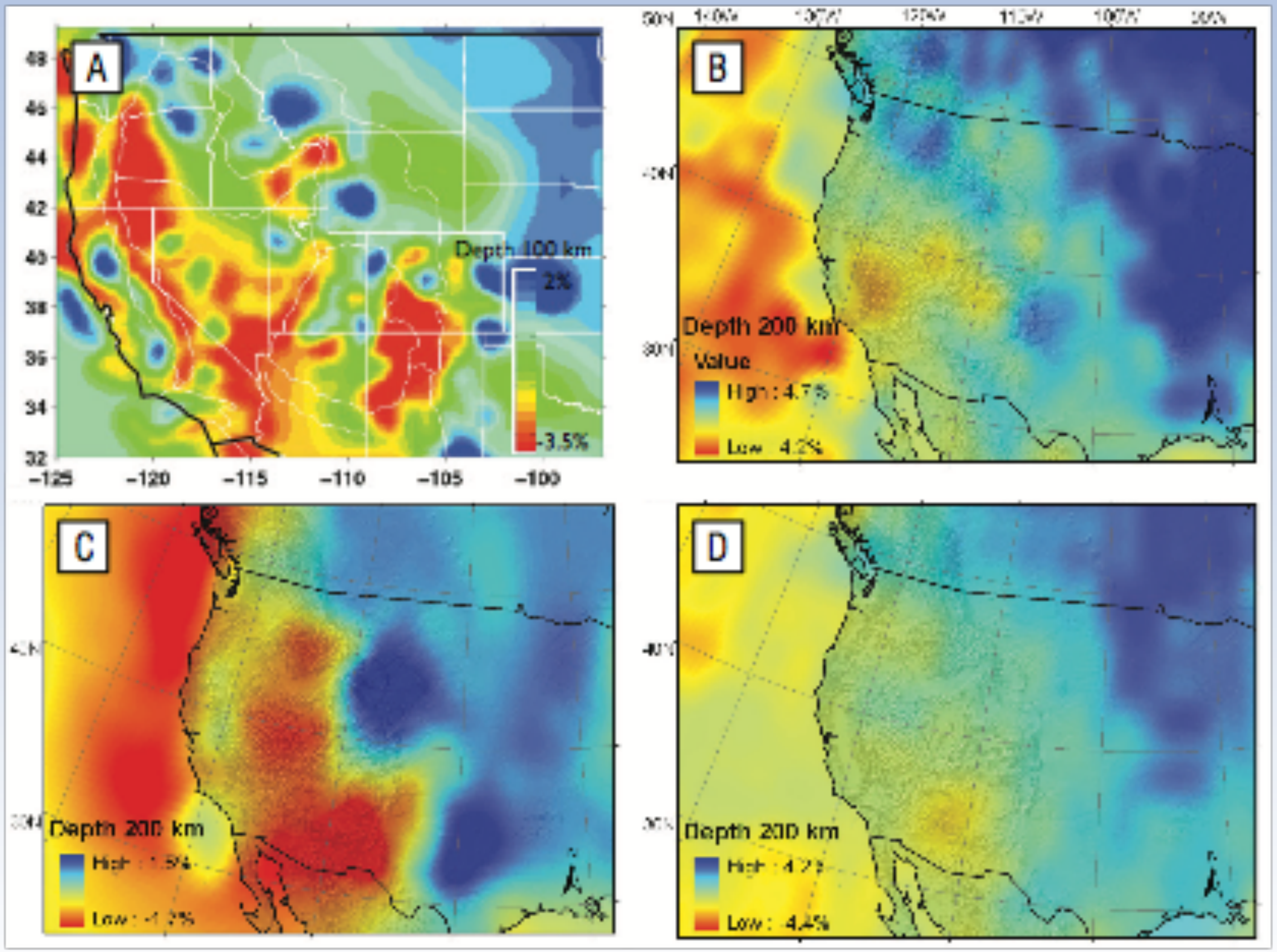
Global Seismicity



US Seismicity

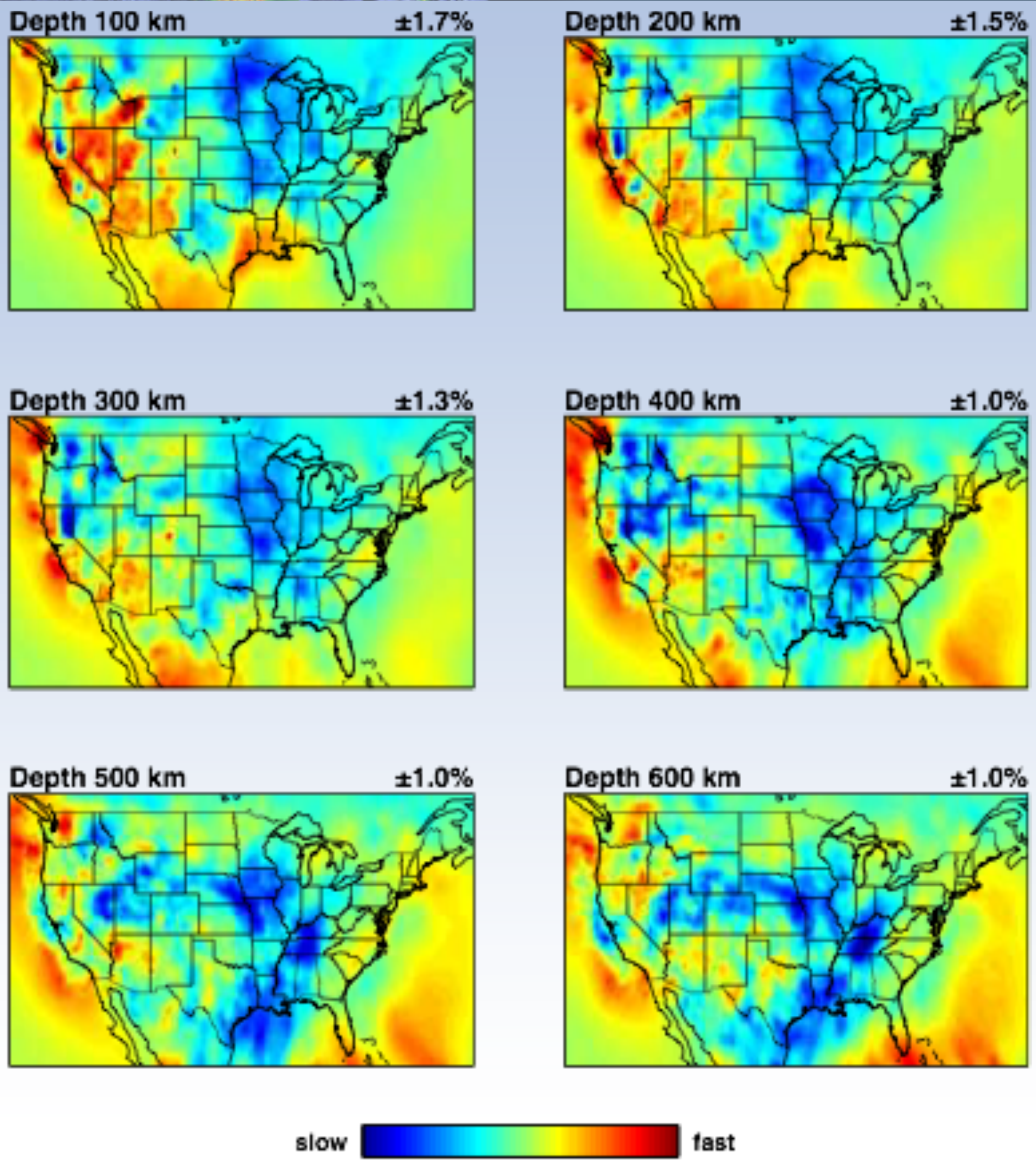


Tomography Before TA

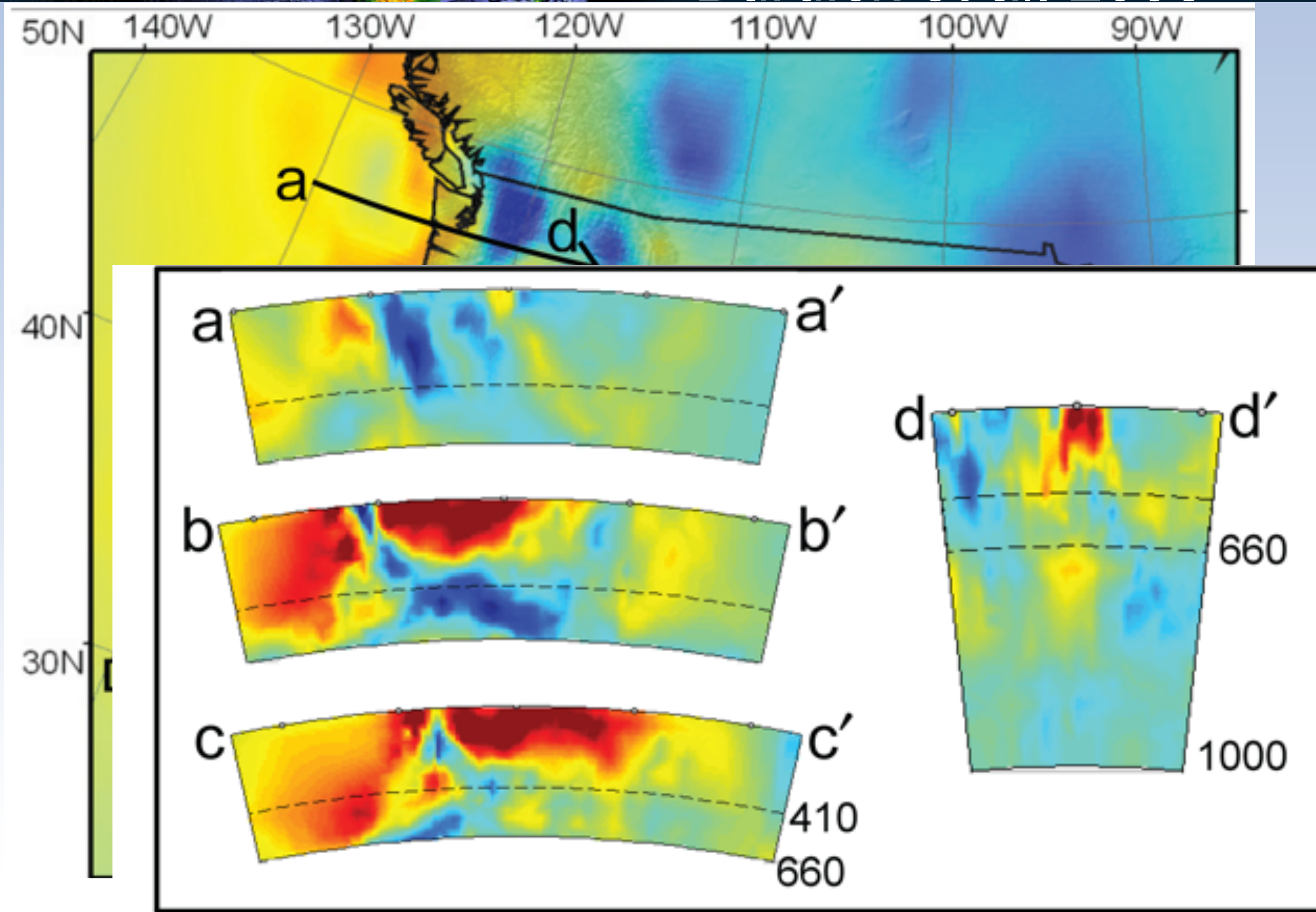


▲ **Figure 1.** (A) Model made by piecing together local tomography studies from Humphreys and Dueker (1994) and inverting with global data set (after Dueker *et al.* 2001). (B) Global *S*-wave model from surface wave diffraction (Ritzwoller *et al.* 2002). (C) Global *P*-wave model using finite frequency kernels (Montelli *et al.* 2004). (D) Global *S*-wave travel-time model (Grand 2002).

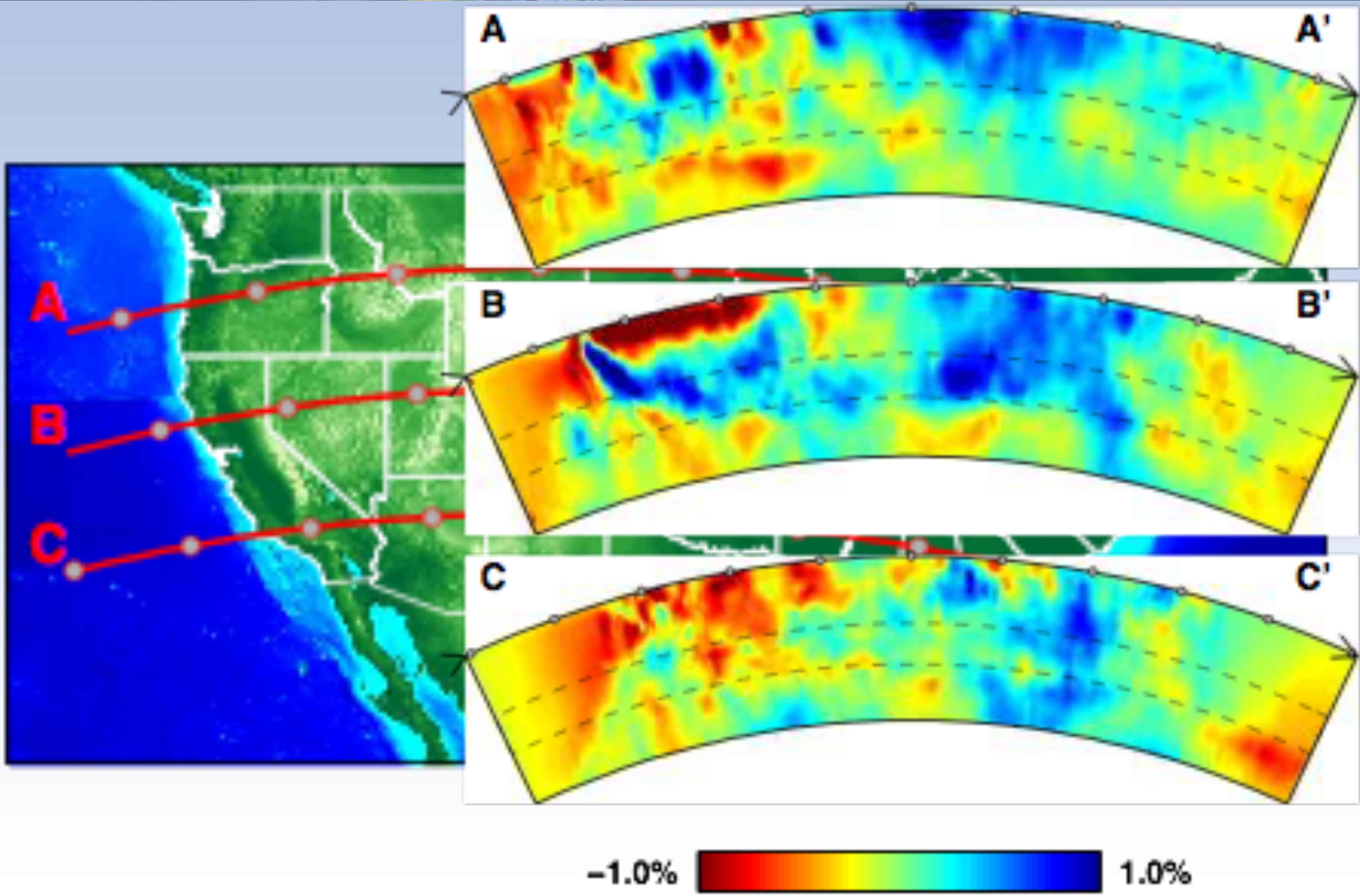
Tomography
Burdick et al. 2016



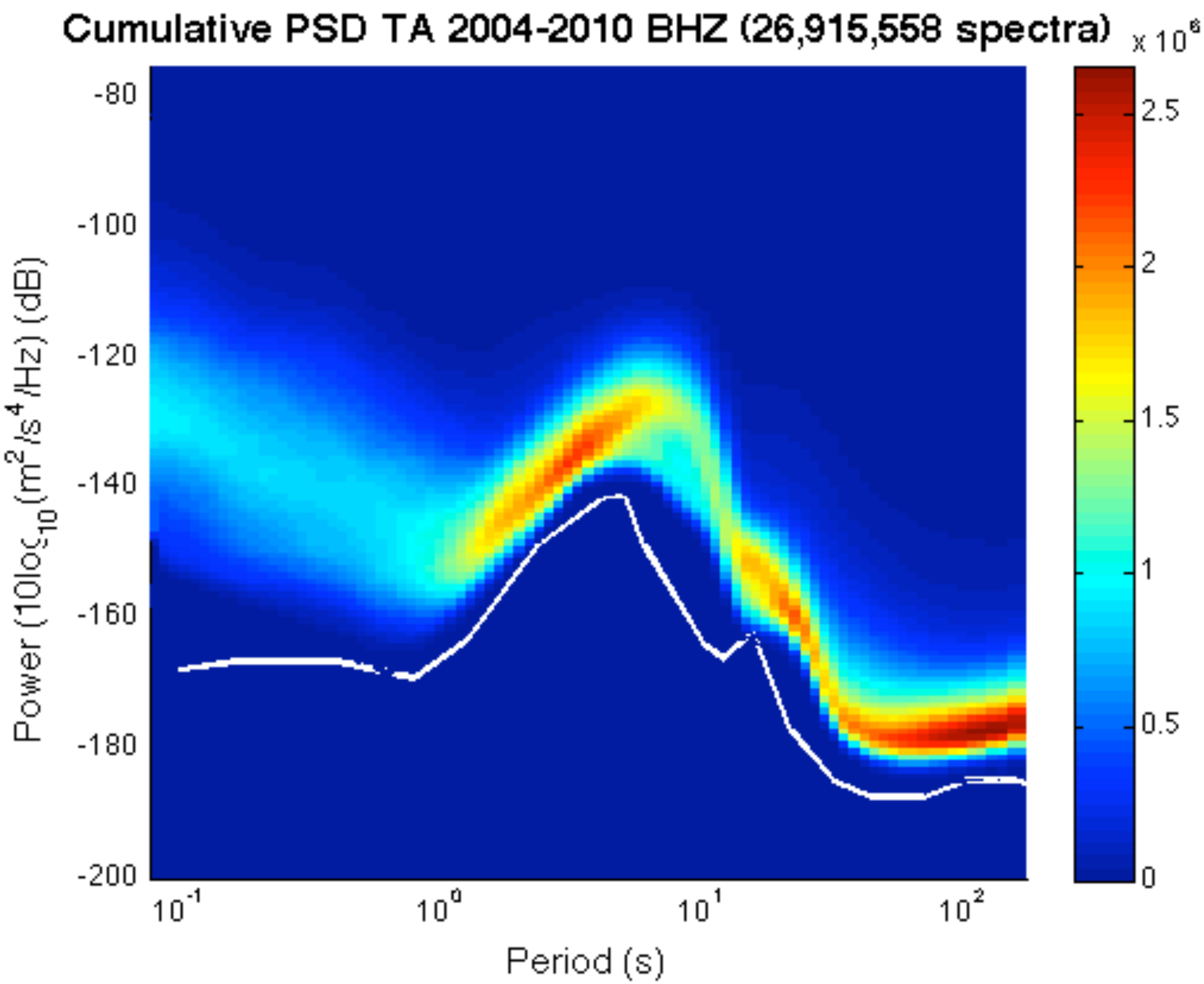
Tomography
Burdick et al. 2008



Tomography
Burdick et al. 2016



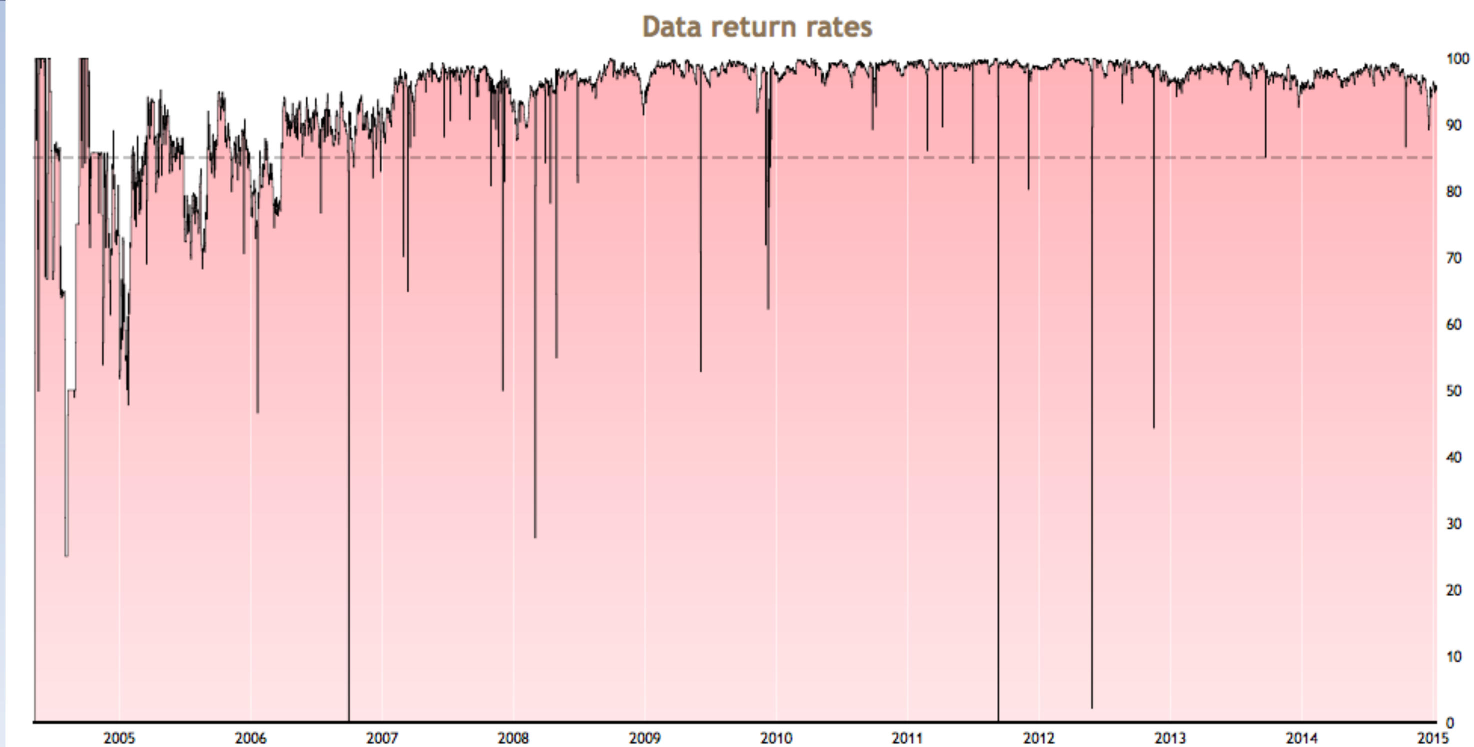
TA Performance

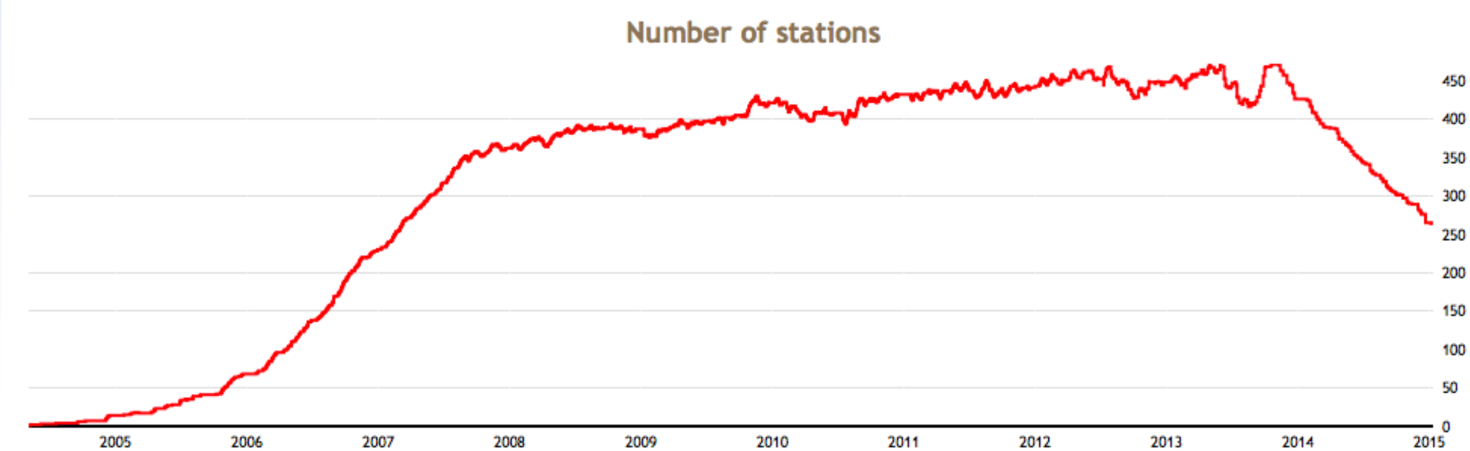


Station noise highly uniform and quite low for temporary installations

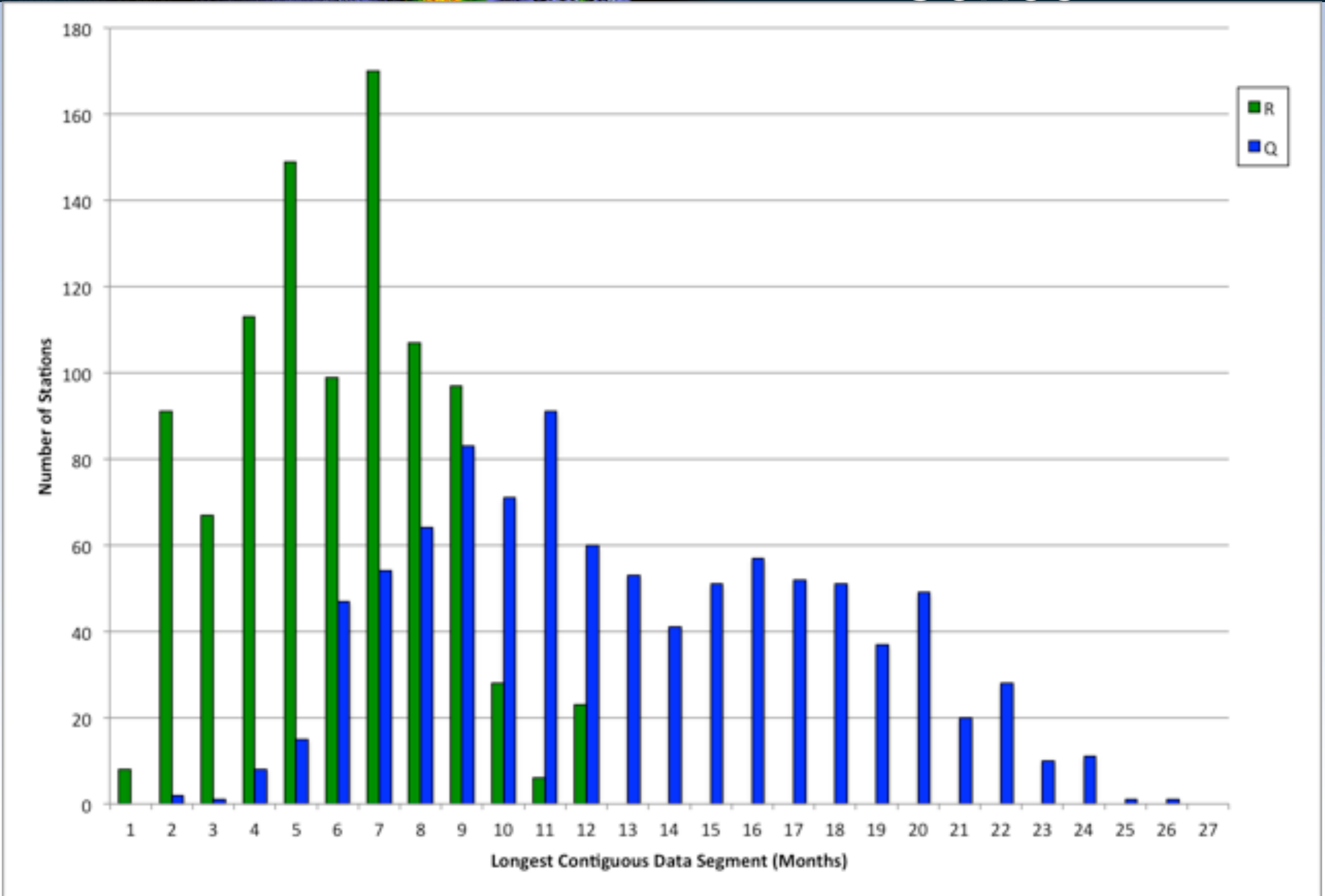
TA RT Performance

Realtime Network availability typically exceeds 98%



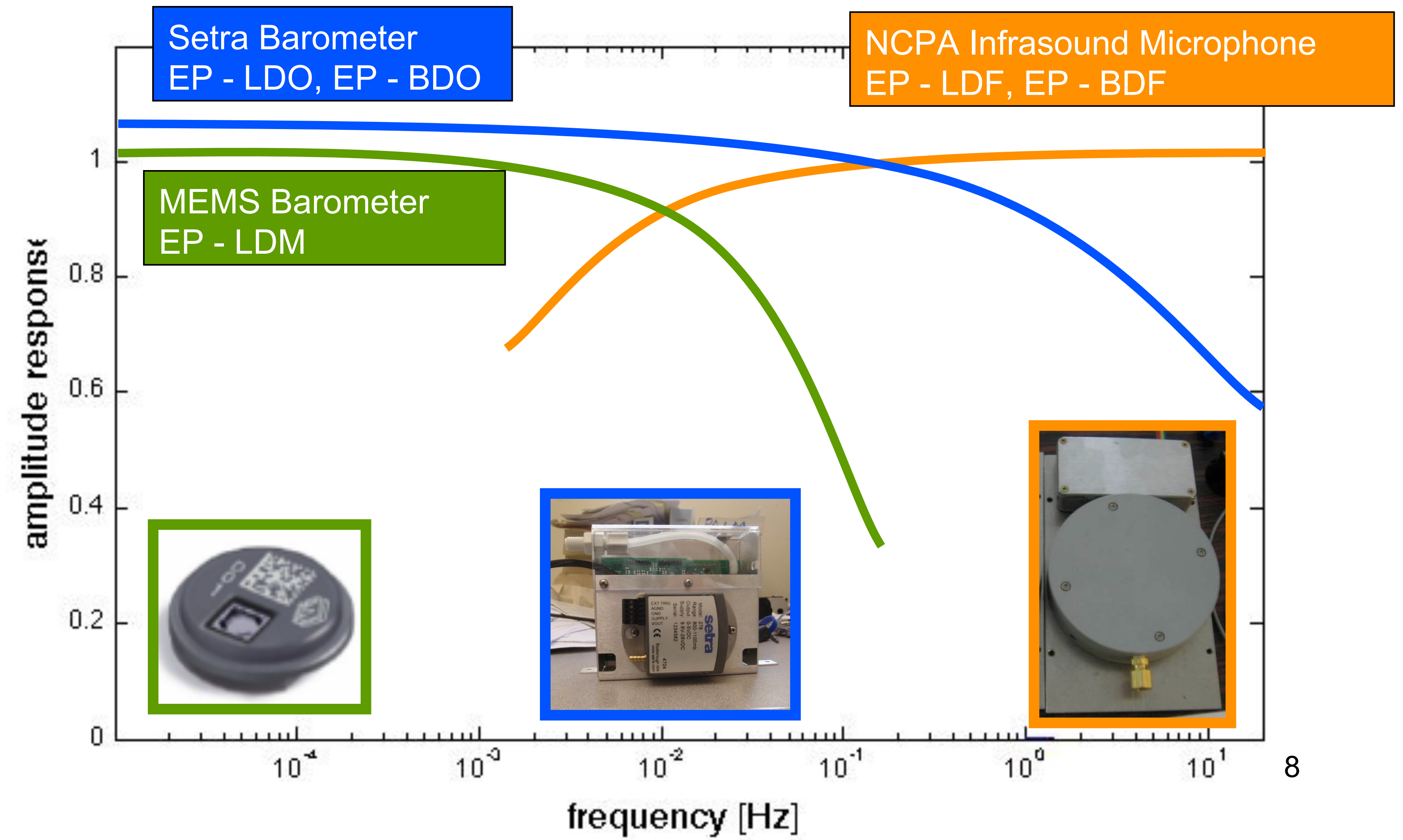


Contiguous Time Series

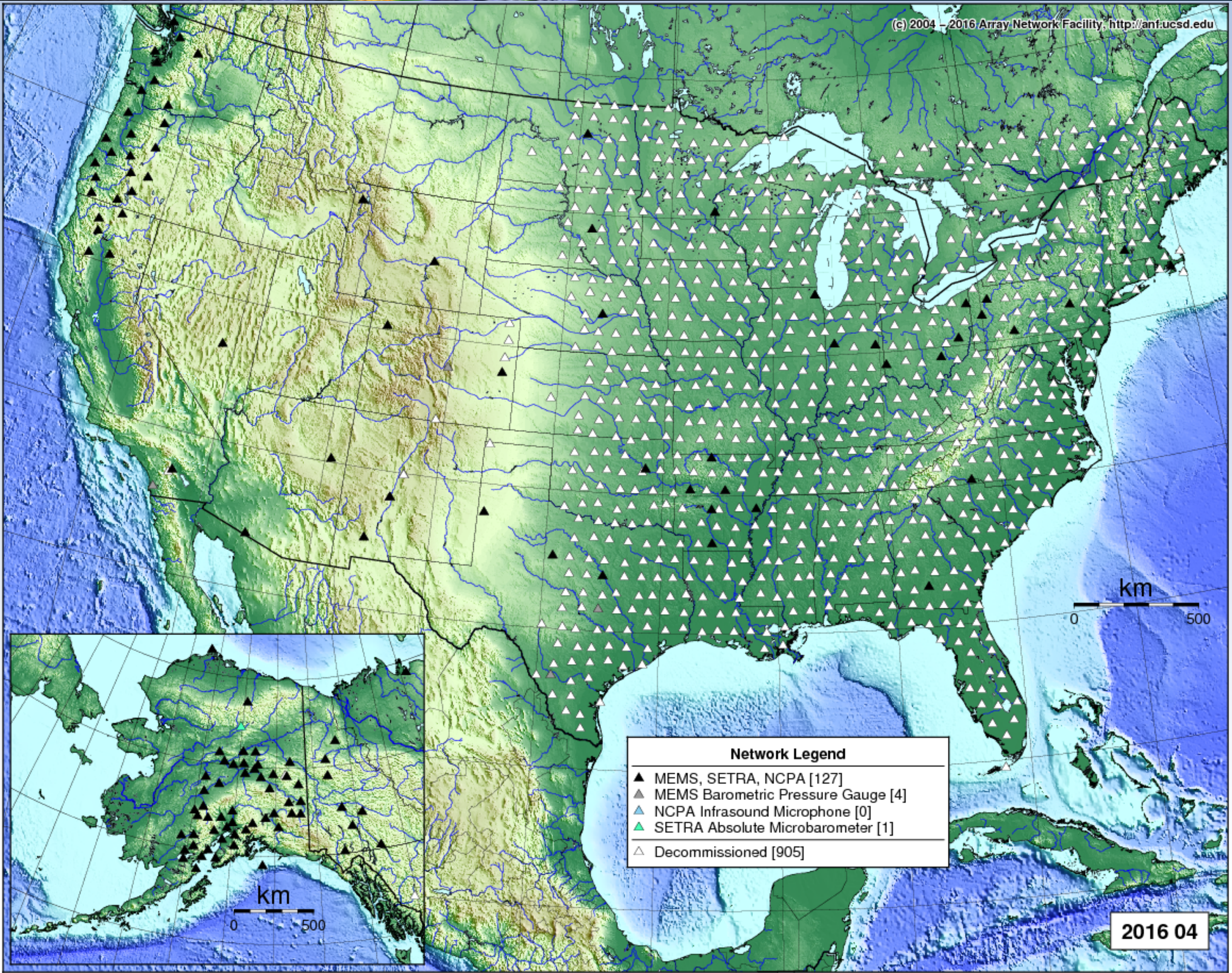


Pressure Sensor Response

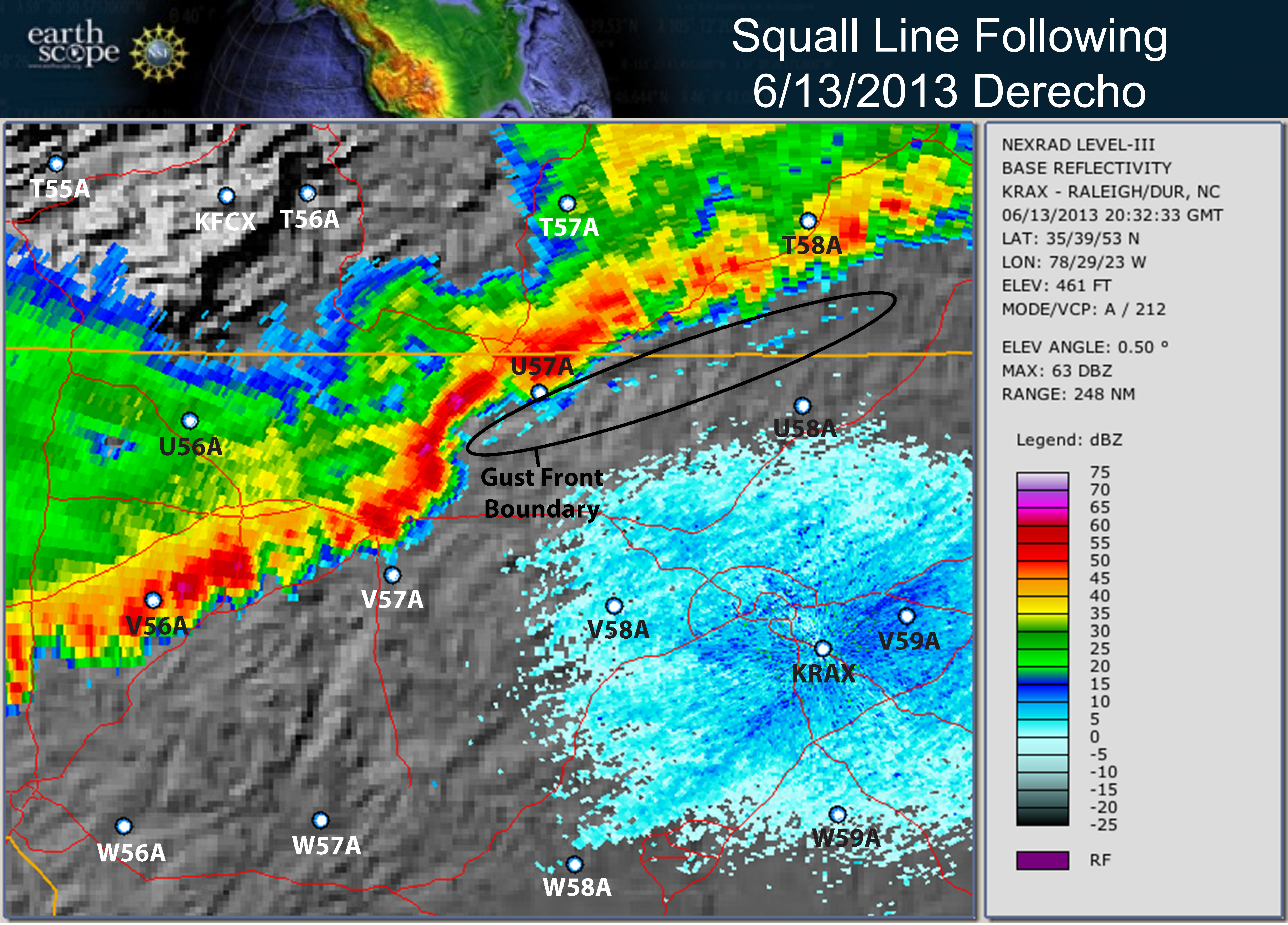
- Overlapping pass-bands provides continuous coverage from DC to 20 Hz



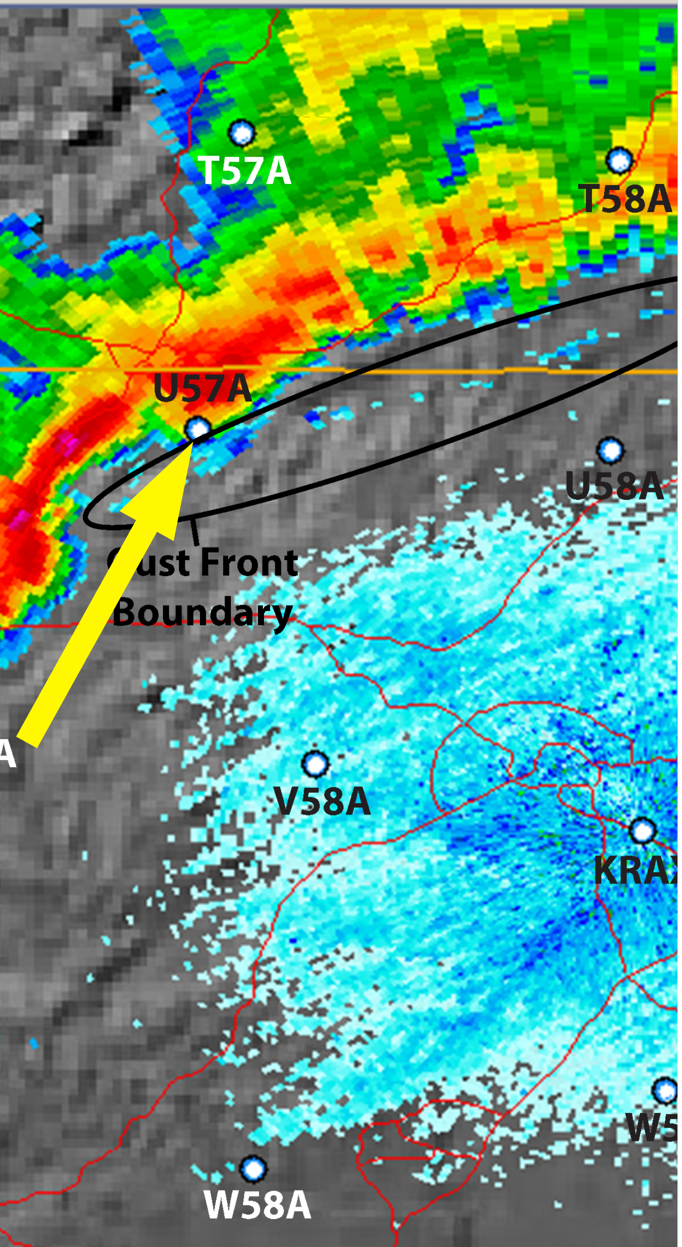
TA InfraMet

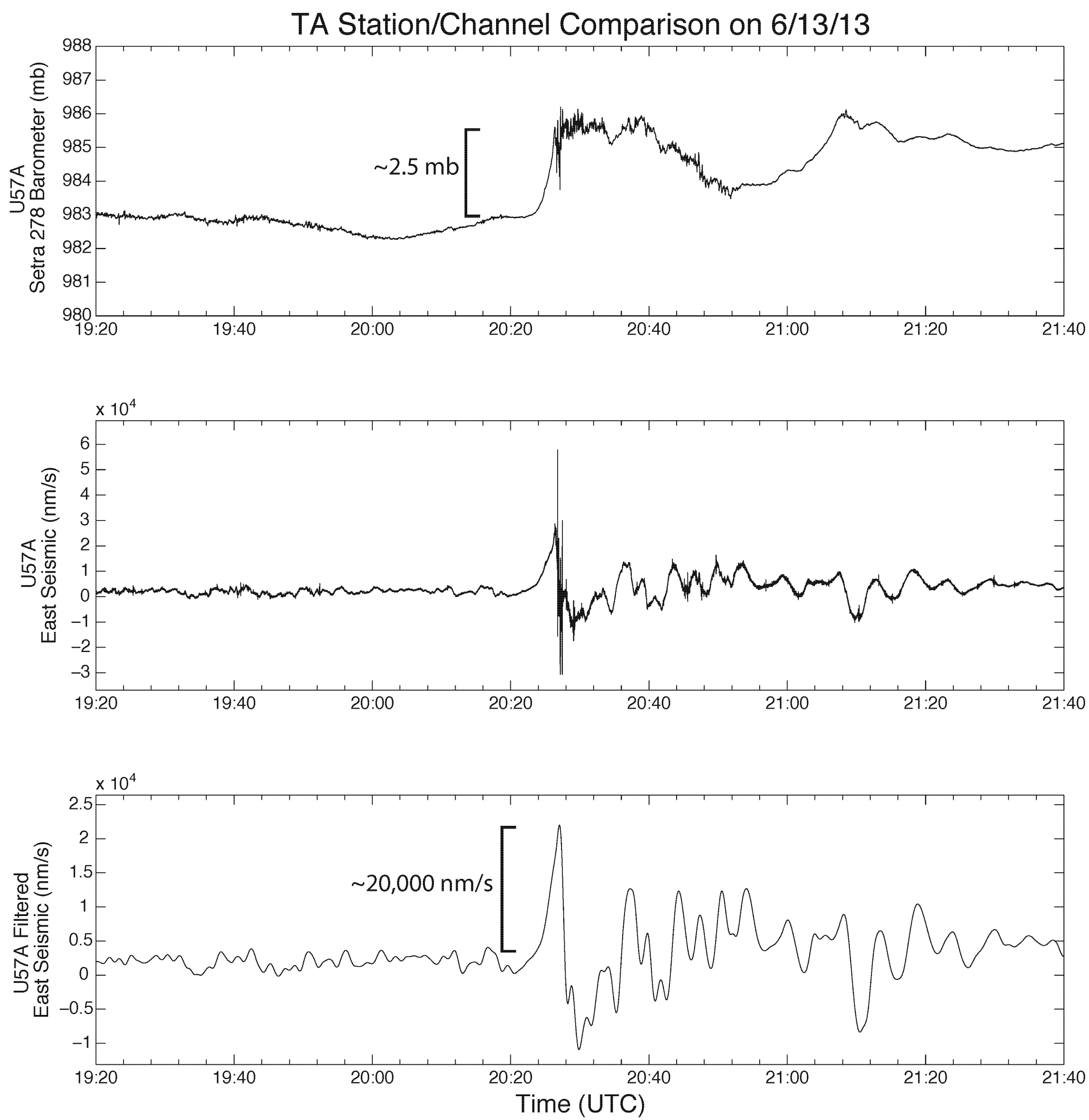

(c) 2004 – 2016 Array Network Facility, http://anf.ucsd.edu
km
0
500
Network Legend
MEMS, SETRA, NCPA [127]
MEMS Barometric Pressure Gauge [4]
NCPA Infrasound Microphone [0]
SETRA Absolute Microbarometer [1]
Decommissioned [905]
km
0
500
2016 04

Squall Line Following 6/13/2013 Derecho

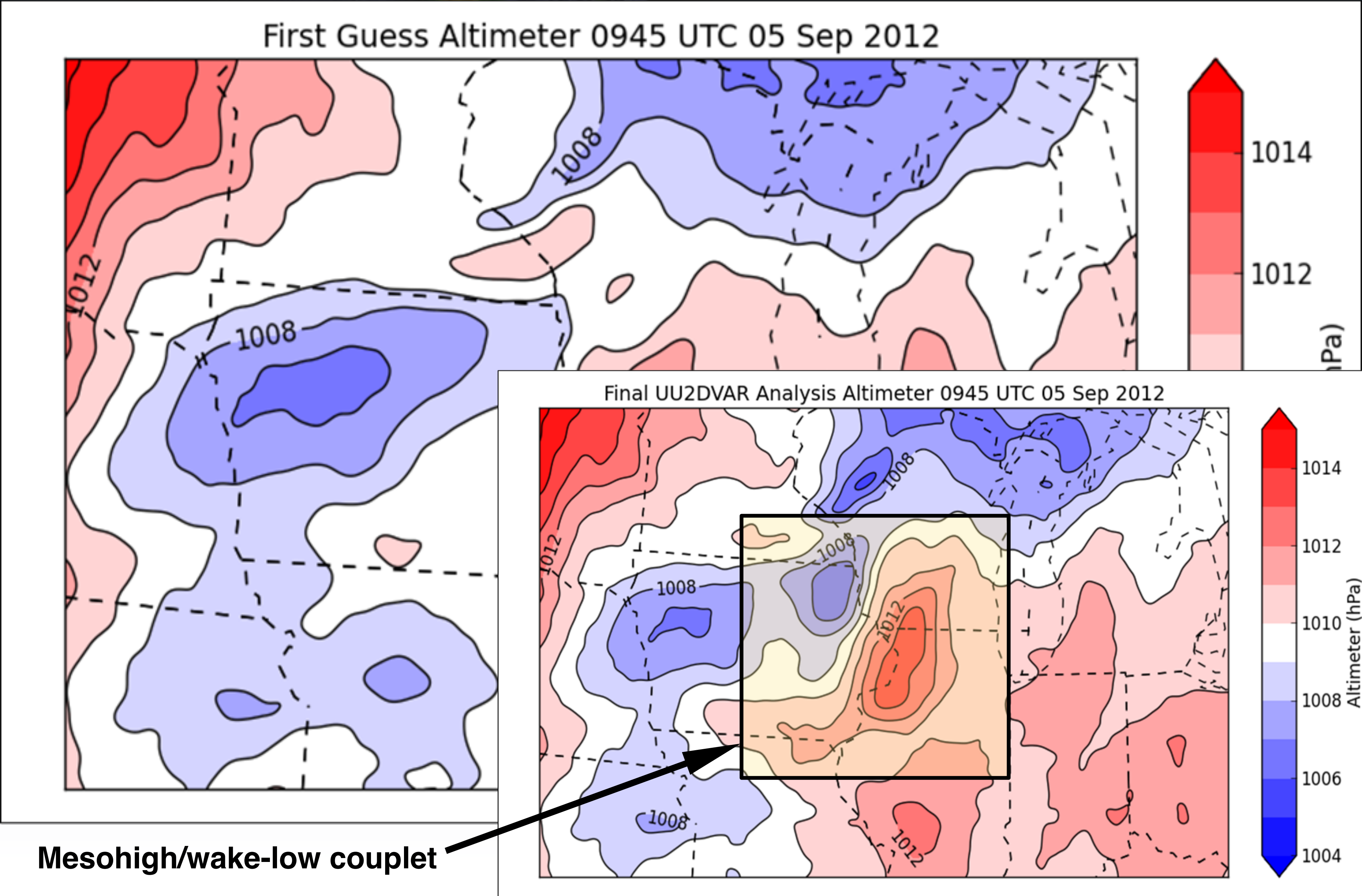


6/13/2013 Derecho U57A



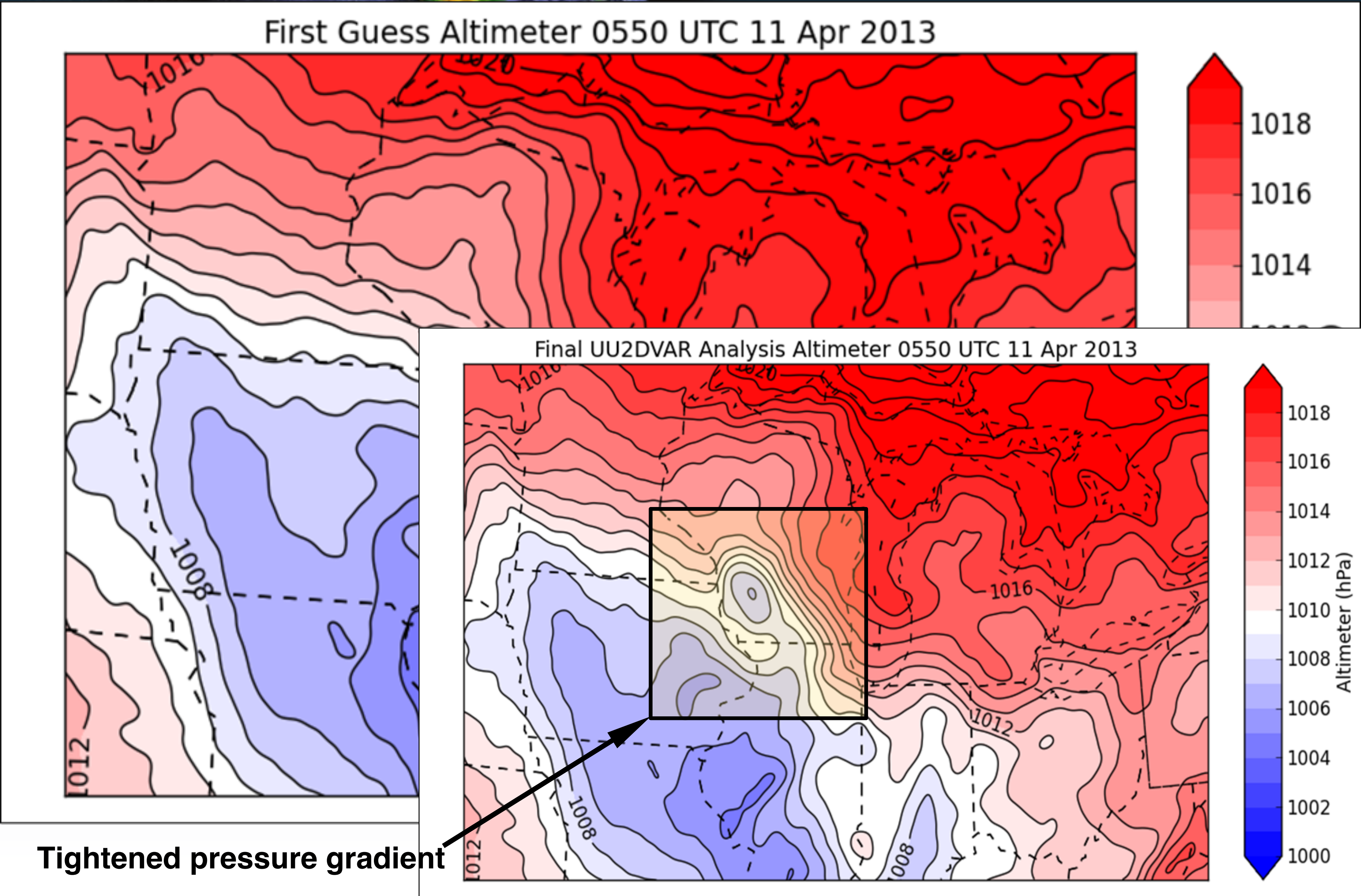


Propagating Mesoscale Convective System - Jacques (2015)



Mesohigh/wake-low couplet

Mesoscale Gravity Wave Event
Jacques (2015)



Conclusions

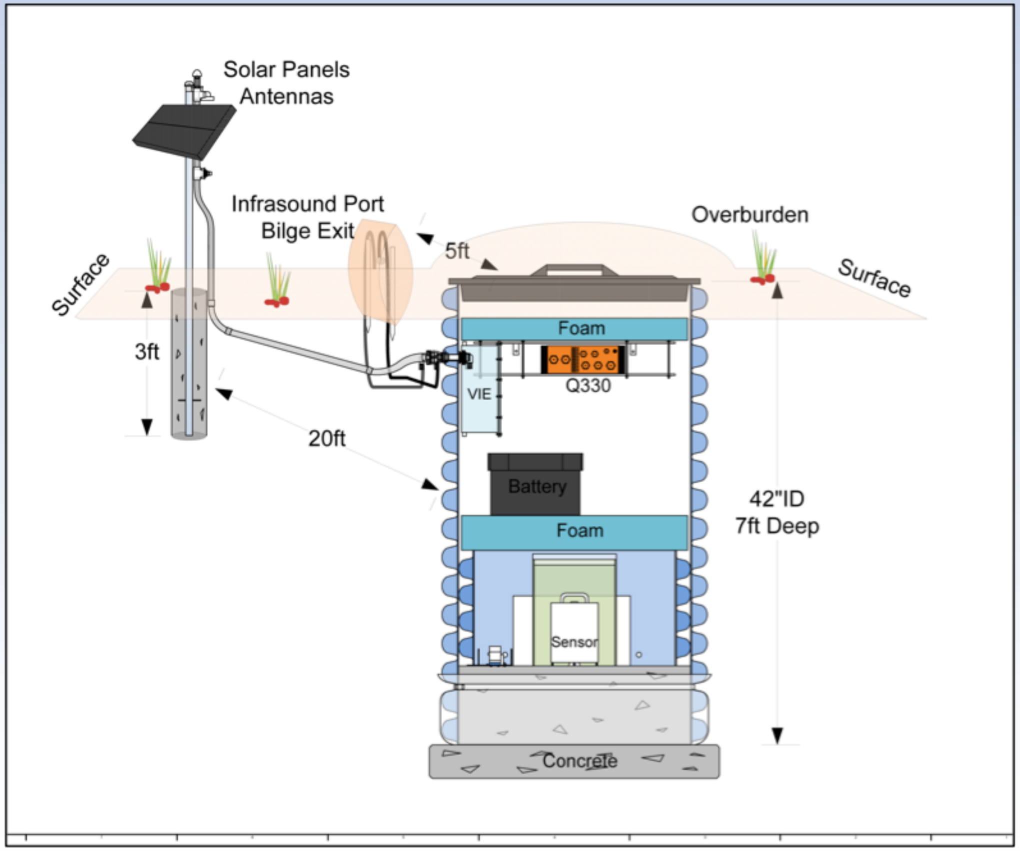
- Meteorological sensors can enhance understanding of seismic data

- Meteorological sensors can create opportunities for collaboration between different scientific communities
  - real time monitoring
  - hazards
  - civil defense

- Seismic networks provide sites, permitting, real time telemetry

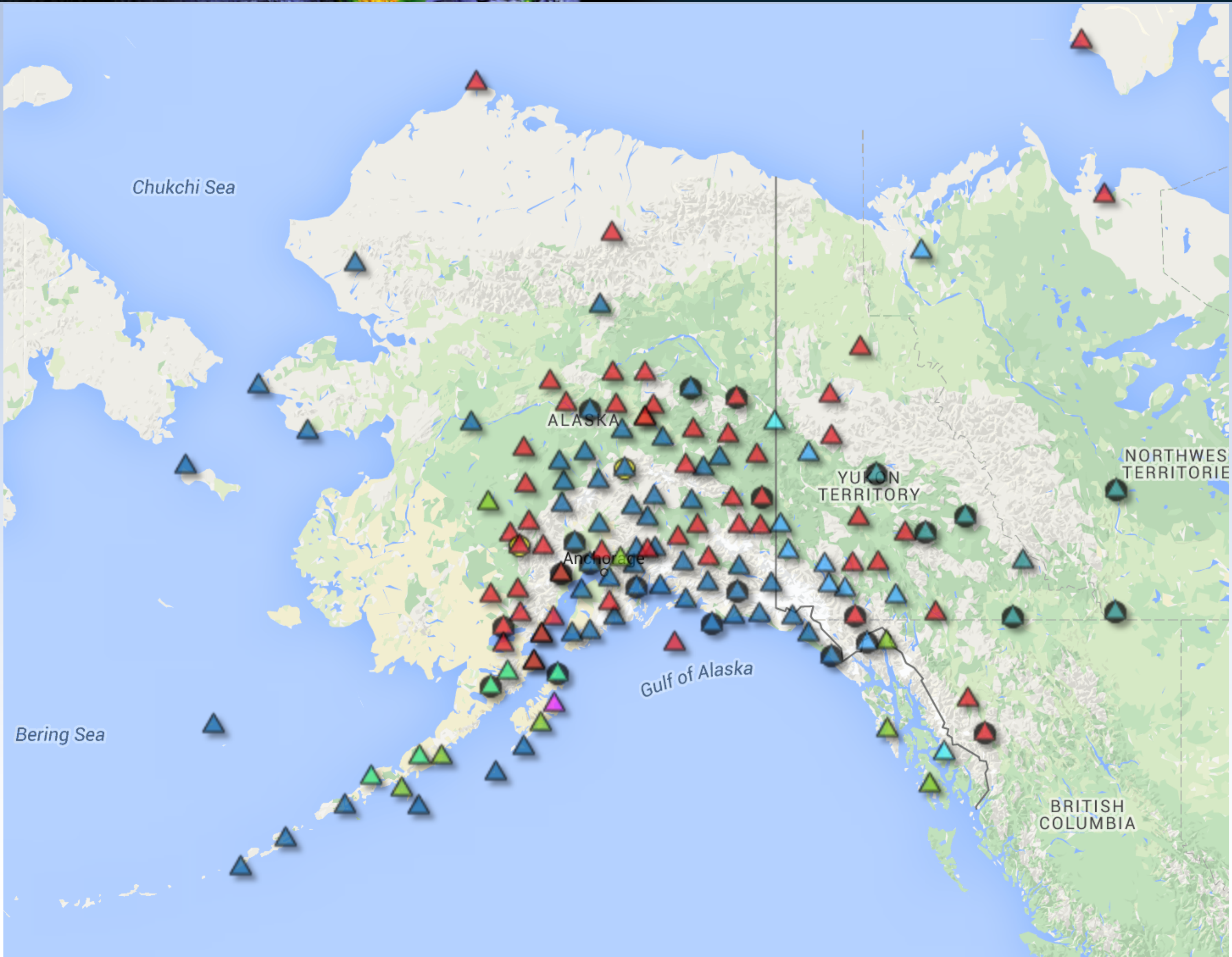
TA Basic Description

- Sensor: 3 component Broadband seismometer & auxiliary sensors
- Datalogger & local data storage
- Power & data telemetry



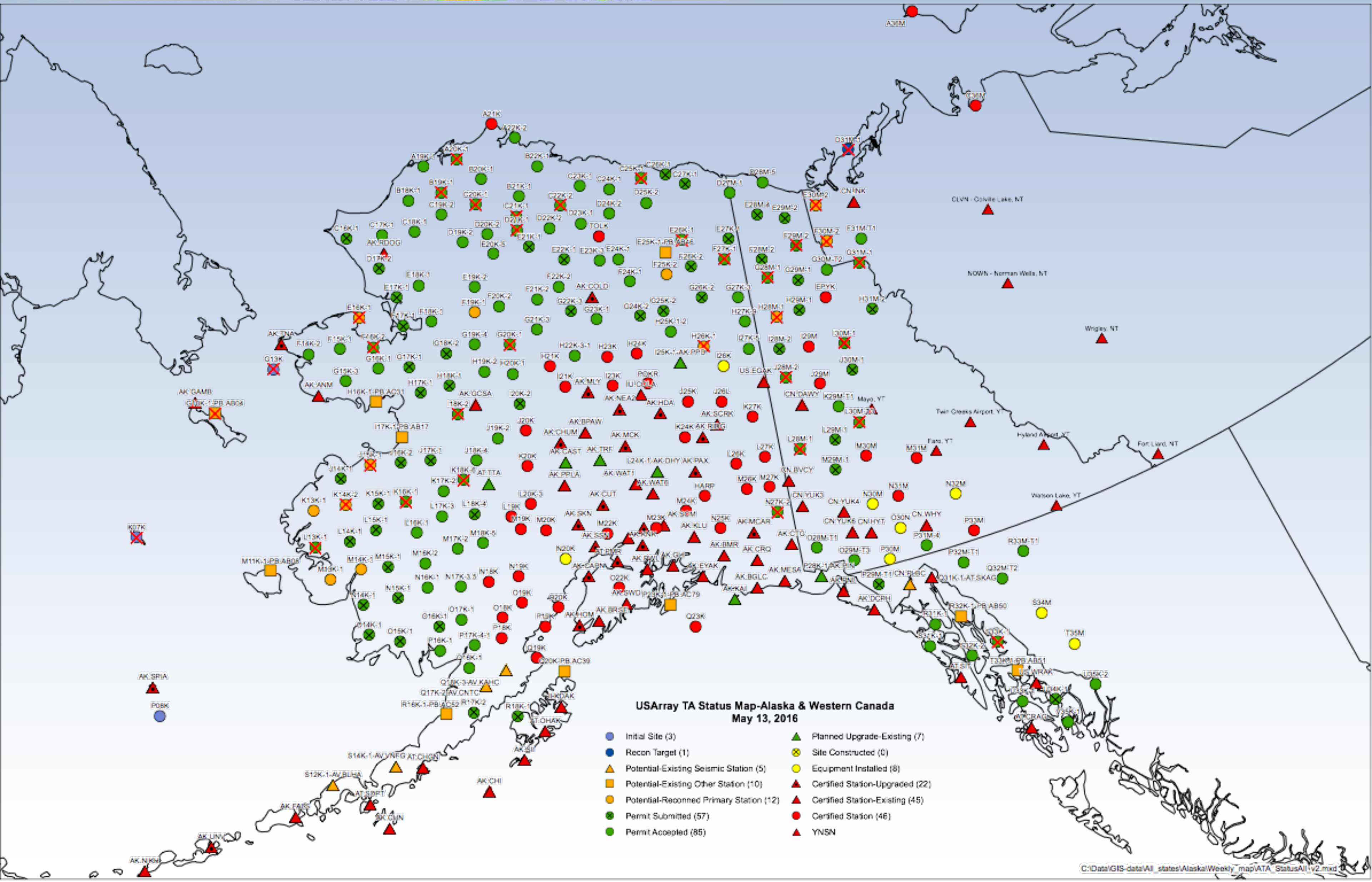
TA Station 345A, MS

Alaska TA May 18, 2016



earthscope

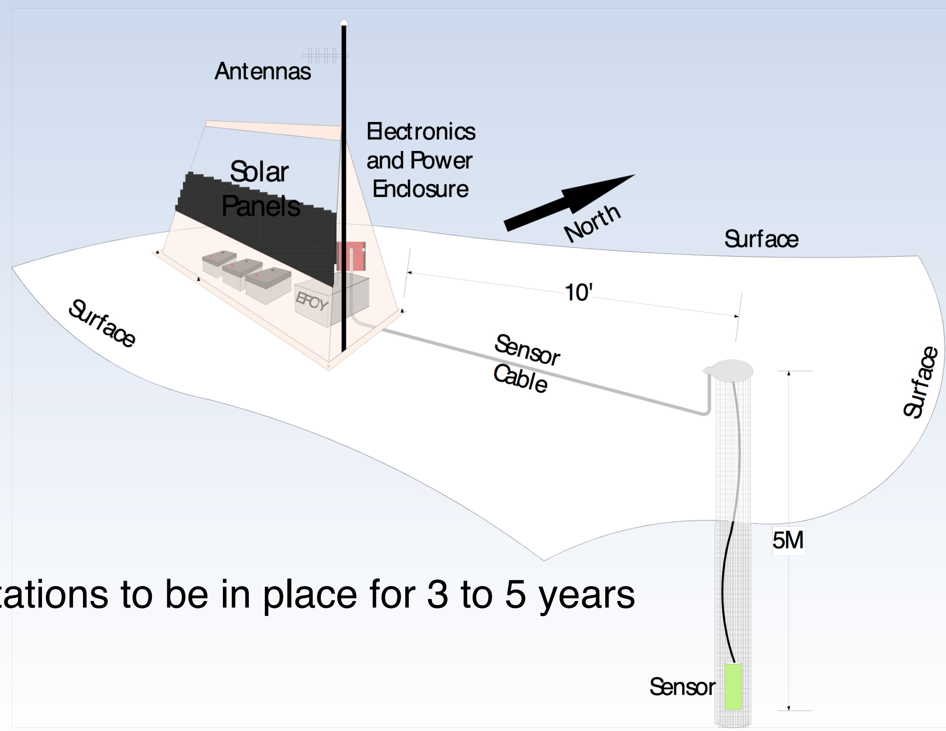
Status of TA Sites May 2016



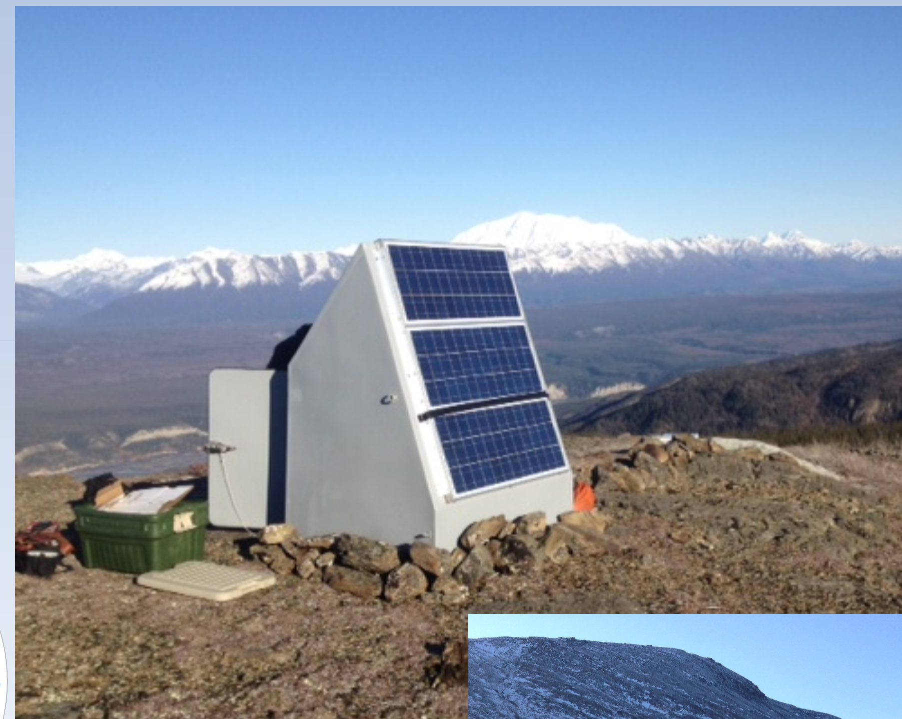
Basic Description of Buried Sensor Design for AK

- Sensor: 3 component Broadband seismometer & auxiliary sensors
- Datalogger & local data storage
- Power & data telemetry

N25K Seismic Station

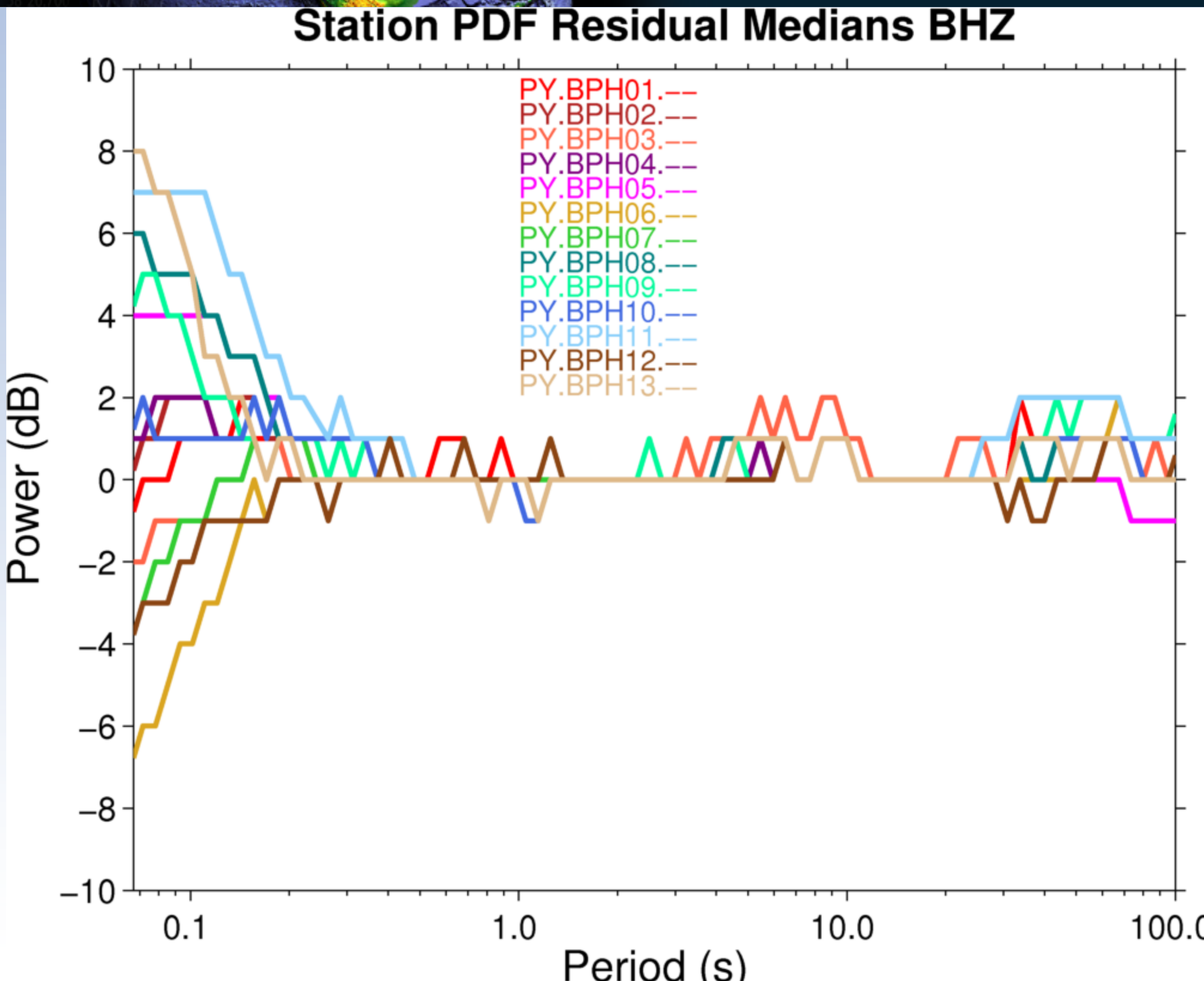


Stations to be in place for 3 to 5 years

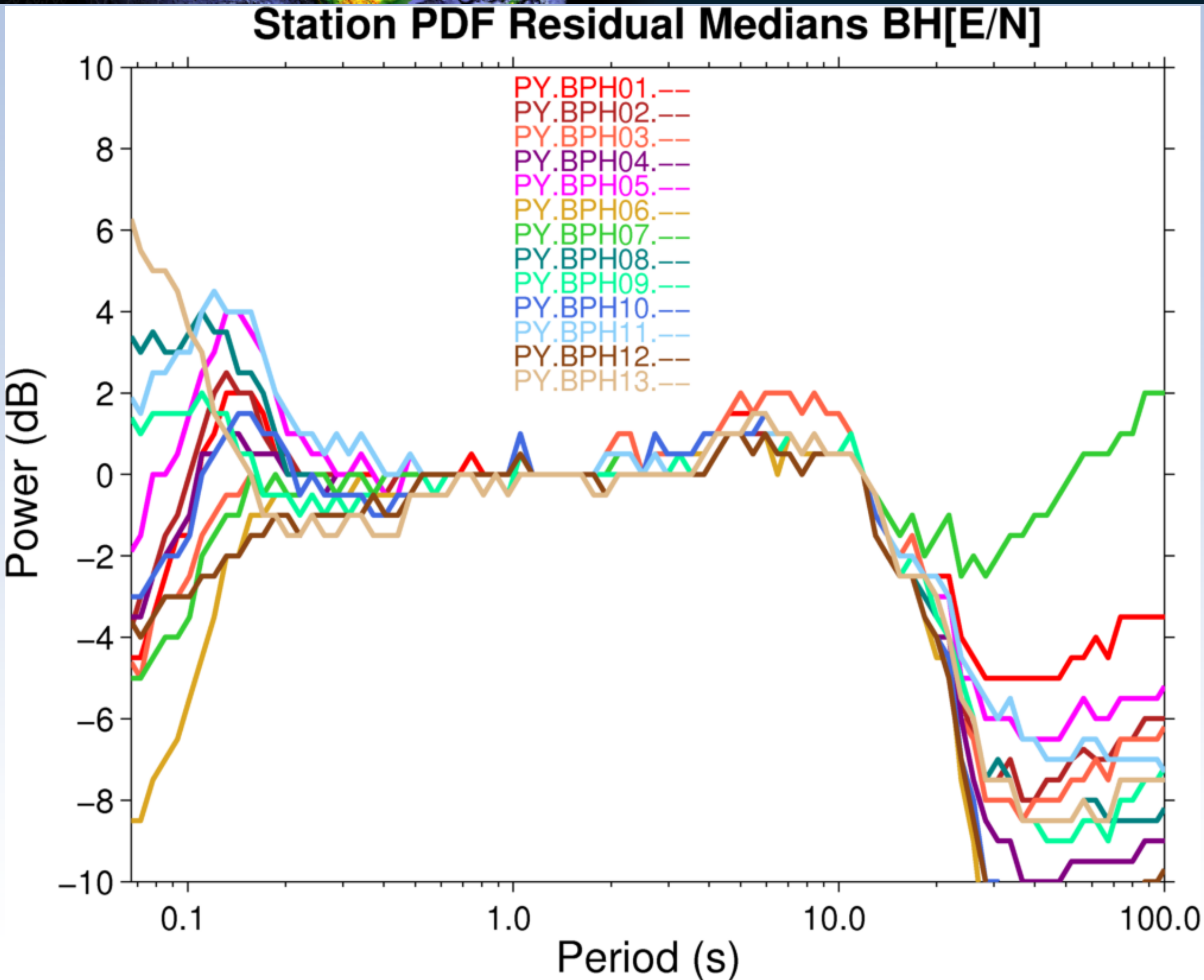


PFO PY Posthole Test

PY-TPFO Comparison



PY-TPFO Comparison



Sensors

- Broadband seismic coverage, 1 and 40 sps
- Two surface barometric pressure channels at 1 sps
  - MEMS
  - Setra 278
- Hyperion Infrasound microphone, 1 sps
- Vaisala WXT520 Weather Stations, 1 sps
  - 25 sites
  - 265 additional sites possible if funding found

Lessons Learned

- Integrated system
  - Sensors
  - Dataloggers
  - Data acquisition hardware and software
  - Resiliency
    - Buffering at stations
    - Onsite storage
    - Failover systems
  - Web presentation
    - Field support
    - Outreach
- Leverage commercial developments
  - telemetry
  - IP networking
  - computer hardware and operating systems
- Software
  - Sustainability and operational costs
    - commercially supported (open source or closed source)
    - open source (who is responsible for support ?)

Summary

- High Quality Data
  - High data return > 99.5%
  - Sensor orientation ~ 2º for 1 sigma
  - Sensor calibration ~ 2% for 1 sigma
  - Accurate timing across all sensors ~ 1 microsecond
  - Low noise
  - Continuous time series. majority of stations > 9 months
  - High density spatial observations spatially unaliased in lower frequency bands
  - Multidisciplinary observations
- Science Returns
  - Improved seismicity observations
  - Improved body wave and surface wave tomography
  - Ambient noise tomography
  - Back propagation for large event rupture inversion
  - Atmospheric research
- Science Opportunities
  - Crustal compliance from atmospheric pressure and seismic data - multi taper transfer functions
  - Develop or improve frequency domain approach to ambient noise analysis
  - Multidisciplinary analysis